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ADA - Art Digital Archive: design driven digital tools for Cultural Heritage

Questa è la Versione finale referata (Post print/Accepted manuscript) della seguente pubblicazione:

Original Citation:

ADA - Art Digital Archive: design driven digital tools for Cultural Heritage / elisabetta cianfanelli; margherita tufarelli. - ELETTRONICO. - (2018), pp. 7-12.

Availability:

This version is available at: 2158/1143790 since: 2020-12-27T19:21:24Z

Publisher:

Asia Digital Art and Design

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05 May 2023

ADA - Art Digital Archive: design driven digital tools for Cultural Heritage

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Abstract
This project comes as part of the REI Lab's (Reverse Engineering and Interaction Design) research activities that, within the DESIGNCAMPUS of the University of Florence, devotes part of its research to the 3D reconstruction and reproduction of works of art and crafts. This paper investigates how the design discipline face problems related to the digitization of artistic heritage and its dissemination, and describes the research and the process developed in REI lab, through the description of two different projects concerning the application of design processes and methods to the field of Artworks using three-dimensional digitization.

Keywords: Design and Cultural heritage, Digitization, Cultural experience.

1 Introduction

The Cultural Heritage, with its historical and aesthetic value, possesses the extraordinary ability to condense in a single object the sense of a whole civilization. the Cultural Heritage is an expression of human experiences, thus it needs to be activated and protected. Its conservation and enhancement requires in-depth documentation, both for its historical and artistic terms, and "for the physical characteristics of position, shape, color and geometry" (Bitelli, 2002, p.9). [1]

In recent years, advances in digital technologies have opened up new scenarios and suggested multiple applications in the Cultural Heritage field. The diffusion and continuous improvement of tools for the acquisition and return of three-dimensional data, allow to document and communicate information, determining new ways of accessing to knowledge.

Current technologies and methodologies for Cultural Heritage documentation can generate realistic 3D digital products, which could be used for:

- Digital archives
- Participatory museum itineraries
- Communication of works of art
- Exhibitions of works or parts not available
- Exhibitions of works or fragments of them
- Research
- Support for diagnostics and restoration
- Communication and dissemination
- Teaching practice

The REI Lab (Reverse Engineering, Experience and Interaction Design), of the DESIGNCAMPUS of the University of Florence, develops digitization processes aimed at 3D restitution of cultural heritage in a Design Driven approach where innovation is driven by design, it does not come from the market demand, but it creates new markets; it does not push new technologies, but gives life to new meanings (Verganti, 2009). [2]

This contribution will describe the activities of the research team aimed at 3D digitization of the "Tribuna degli Uffizi" in Florence, and of two Egyptian Sarcophagi belonging to the Musées Royaux d'Art et d'Histoire in Brussells. In these projects digitization has been interpreted as a tool for enhancing and spread the knowledge contents.

This paper intends to describe the role of Design in the disse-

mination and communication of Cultural Heritage through the description of two projects related to digital technologies. In this scenario the cultural object can be considered as a cultural product, as the technology transfer and the entire process of digitization are seen as a result of a design process.

Cultural Heritage offers identity and a sense of emotional belonging, it has a creative and constitutive role in human development; in this scenario the artistic good is understood as an experiential good, of which fruition needs to be designed (M. Franch 2011)[3].

2 The design approach

The diffusion and development of digital technologies had radically changed the way in which museums and cultural institutions offer content to the public. In this regard, the academic field has been discussed about the connection between the Design discipline and Cultural Heritage for several years; this is due to the profound transformations faced in both Design and Cultural Heritage areas [4] .

Through the description of two different projects we intend to bring out the technology issue, which does not represent a solution to all the concerns about archives, protection, use and enhancement of the Artworks, on the contrary it represents an instrument and, as such, it should have empowering and emancipating capabilities.

One of the most interesting aspect in Design for Cultural Heritage seems to be the transfer of innovative processes from different fields of application to the cultural sector, which is usually willing to experimentation. [5]

Among the design skills we considered the ability to “shape” the contents to allow the sharing and the dissemination of knowledge. “To shape” not only in material terms, but also in the Design of as in planning the process through which this relationship takes place [6]. Design is a discipline that operates in contemporary complexity, in relation to different fields of knowledge; it can contribute to the enhancement of goods using the potential offered by new forms of communication, creating systems, tools and lexicons for the construction of adequate and participatory [7] “communicative architectures”.

3 Tools

In these particular cases, The three-dimensional acquisition process developed by the REI lab makes use of a manual 3D scanner; the speed, the accuracy and the absolute security in potential damage to the work, makes it the ideal device for scanning works of art and artistic artifacts [8].

The system is equipped with an optical head with four cameras, able to acquire the three-dimensional shape of an object with noticeable precision. The scanner projects a light on the Artwork, obtains a set of three-dimensional coordinates that refer to a large number of points and generate a range image that describes the surface of the scanned object (Fig 1). The tool operates with an integrated processing software that manages point clouds and meshes. The obtained model than needs different treatment, according to the required results.

Each scanning operation represents a case itself. Therefore the experience, knowledge and design skills of the designer operator generate constant variations of the system. Frequently, is possible to have the impossibility of access to portions or to the whole object, other problems may be unacceptable distances, the need to adopt special devices (forklifts, photographic equipment, etc.). Therefore the scanning process requires operational flexibility, with the awareness that each case needs a specifically designed solution.

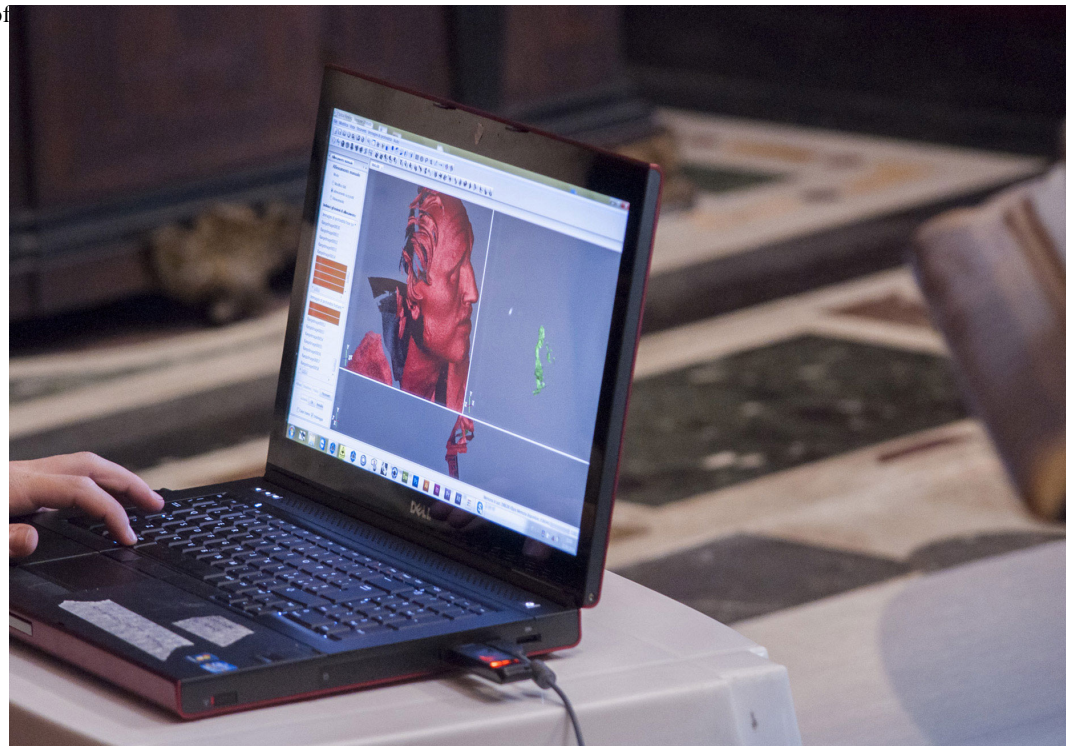

Figure 1: Sample of a range image that describes the surface of the scanned object.

4 The digitization process

The acquisition process has been applied to the Tribuna degli Uffizi in Florence and to two Egyptian sarcophagi of the XXI Dynasty, stored at the Museès Royaux d'Art et d'Histoire in Brussels. It will therefore be described through these two case histories.

Figure 2: Digitization result for the Tribuna degli Uffizi

Case study 1. La Tribuna degli Uffizi

The Tribuna degli Uffizi is a precious octagonal room in the most known Galleria degli Uffizi in Florence. After the restoration completed in 2012, and due to conservation reasons, visitors can not access it except by looking out of the three entering doors.

The aim of the Tribuna digitization project was to give the public an opportunity to visit the room and its content from a closer point of view (Fig. 2). Precisely, the purpose was to provide visitors with an interactive screen that could allow a

Figure 3: Digital reconstruction of the vaulted ceiling

virtual approach to the works where it is not physically possible, in order to admire the details, obtain information, observe the works and their container from an unexpected point of view.

For the Tribuna degli Uffizi the relief operations proved to be extremely complex due to the difficulty of accessing large portions of the works and the impossibility of moving them.

The Tribuna is a very richly decorated environment composed by a vaulted ceiling with about three thousand mother-of-pearl settled in a layer of red stucco (Fig. 3). Walls are decorated with frescoes and it hosts treasures like fifteen Roman statues belonging to the personal collection of Francesco I dei Medici and a table that represents one of the most important examples of Florentine mosaic.

The first step of the digitization process was a traditional architectural relief, in a match with photographic documentation, then all the statues in the Tribune were 3D scanned; there were fifteen statues in total, five larger and ten smaller.

The Statues bases were identified in two categories: a type with square morphology has undergone a traditional type of relief, the second one rich in decorations, details and undercut surfaces, has seen in the scanner the optimal tool for its relief.

Range image is the technical name of a single acquisition. The The number of range images should be adequate to generate a complete model, with the lowest possible presence of "holes". Holes that are formed on the embryonic 3D model are nothing more than the areas of shadow that the scanner cannot acquire as it only registers the points in which the projected light bounces (Fig 4.). Hence, for this reason the competence of the

operator / designer plays a fundamental role in order to obtain a quality model. During the acquisition the team realized that the whole process need to be planned and designed from time to time in order to obtain an optimal result.

Figure 4: 3D scanner and its projected light that bounces on the arwork.

The product obtained from the scanning process is a considerably dense point cloud that needs to be transformed in a high definition 3D model (about 10 or more millions of polygons). In relation to the final objective, the model has been manipulated in order to obtain a lighter file (in terms of megabytes), but appropriately defined according to quality and details. Then, borrowing notions about 3D modeling in gaming, each model was treated as follows:

- Textures UV mapping
- duplication (the model has been duplicated to intervene on the copy, leaving the original unaltered)
- second model decimation (extreme reduction of polygons until losing all the features of the model)
- overlapping (the very high-definition texture "dress" of the first model was given to the decimated one, thus obtaining a defined but light 3D model in terms of megabytes)

The lightness of the model is fundamental in relation to the output expected from the reconstruction: recreating an environment and its content on digital support and allowing the user to navigate and explore the environment in detail like in a video game.

Case study 2 - Museès Royaux d'Art et d'Histoire di Bruxelles.

The Istituto Europeo del Restauro, based in the island of Ischia, has promoted, within the Museès Royaux d'Art et d'Histoire in Brussels, an innovative tour that has allowed the public to participate and follow in real time the restoration operations for two Egyptian sarcophagi of the XXI dynasty. REI Lab participated in this project with the aim to support the wood restoration through the use of 3D models in order to generate scientific, informative and disseminating material.

The REI Lab team applied almost the same process to the sarcophagi belonging to the Museès Royaux d'Art et d'Histoire in Brussels.

Inside the exhibition itinerary of the Egyptian Museum in Brussels, a glass capsule was built (Fig. 5) with the purpose of hosting restorers working on the sarcophagi.

On this occasion the scanning process was integrated with the color relief as well; this substantial difference has permitted to detect not only the wooden surface with its characteristics and irregularities, but also the polychrome coating of the sarcophagus (Fig. 6).

The relief of the Sarcophagus polychrome coating involved some precautions about the lights in the environment, which should be constant and preferably cold. Moreover, as the mechanical process of acquisition undergoes the influence of the light, it is influenced also by the colors of the object (for example, the black color absorbs more light than the others); therefore the acquisition process has been optimized by setting a constant light set for the entire duration of the work.

The elaborated scans were subsequently used as a support for the restoration intervention. Using the final 3D models (Fig. 7) it was possible to compare the works before and after the operation, simulate, at least in part, the restoration itself. The models were a fundamental support for the drafting sheets of the restoration intervention report.

Figure 5: Spaces in which the restoration and the scanning activities took place.

5 Findings and discussion

The operating methodology and procedures of digitization of Artworks used by the REI lab was initially used for the creation of digital archives in Italian historical manufacturing companies. The process has been subsequently transferred to objects of historical and artistic interest.

This procedure allows the development of a quick an agile 3D scanning process, with a focus on the realistic quality of the finished digital product, on the communication and dissemination possibilities of a three-dimensional digital model.

The attention paid to perceived qualities can be explained "in the emergence of the theme of "design of experience as the last frontier of design. [...] The ability of design to prefigure scenarios with attention to new contexts of use, becomes a key competence supporting the innovation process, it sometimes assumes a consultative and autonomous dimension in which

the focus of the project is not the product but the scenario itself "(Manzini, Jegou, 2004, p 189)[9].

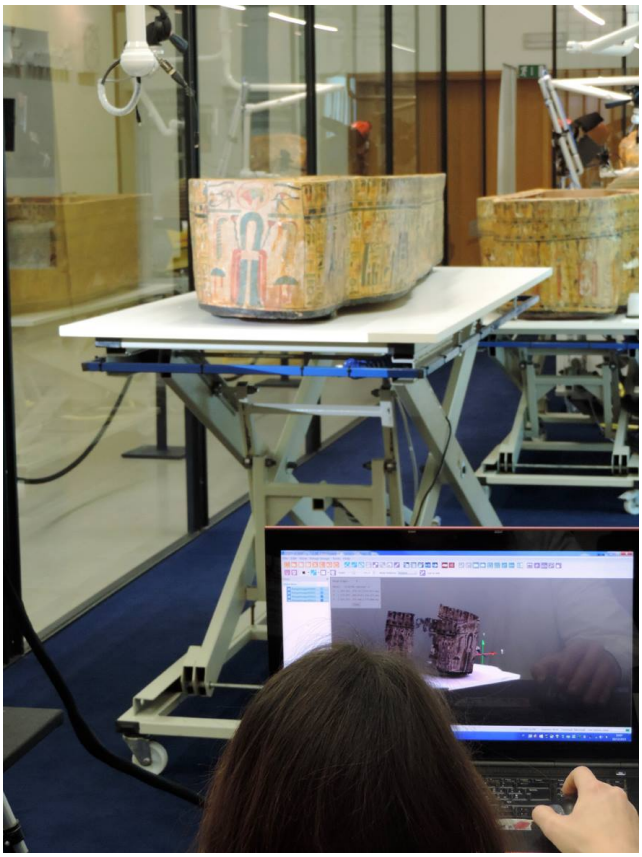

Figure 6: The relief of the Sarcophagus polychrome coating.

Another aspect, integrated with the case studies described, is based on the transfer of knowledge from other fields of studies. In the Uffizi project, the figures involved were programmers, art historians and designers, with parallel and simultaneous interactions between each other from the beginning to the final application. On the other hand, in the Sarcophagi project, were involved designers, restorers, physicists, chemists and an egyptologist. The process was implemented in a shared manner, combining the individual specificities in a transversal and contextual way.

Today it is increasingly necessary to coordinate the disciplines and to overcome their borders, which should be considered permeable, expandable and transferable. Only when we are able to overcome these limits, then knowledge can expand beyond the disciplinary boundaries. [10][11].

Discussions, research and debates on the methodology of the transdisciplinary approach applicable to all fields of knowledge are increasingly current. Alfonso Montuori in his vision on transdisciplinarity offers a completely different way of thinking about knowledge and offers a wonderful opportunity to investigate our fundamental assumptions about knowledge, its generation and research. Transdisciplinarity does not require exhaustive knowledge of all disciplines, but its focus lies in "understanding how knowledge is created" [12].

Figure 7: Final result of the sarcophagi project.

6 Conclusions

Substantial progress in the digitalization of Cultural Heritage has enabled the acquisition through digital products of a rich archive of wealth and specialized knowledge. This research intend to contribute to make Italian cultural heritage not only a heritage to be preserved but also a pool of values on which develop cultural and economic models, in order to support research, conservation, restoration and models of fruition of the Goods themselves.

The described process, developed during this research, allowed to spread the values of knowledge and use of the works through new design-oriented interactive models, for their conservation, dissemination and enhancement. The research, conducted through the design culture, leads to compose new services regarding the enhancement of heritage, as well as to outline new museum scenarios and new models for the management of the artistic heritage.

The digitization practices, for the Artworks in this paper, have produced inclusive enjoyment solutions; digital culture fosters relationships and communication and allows, through its languages, to transmit and express the cultural heritage generating new meanings. The digitization process is Intended as a generative concept, the obtained archive can define and sorts knowledge, it allows to give structure to information and represents a relational system between context and content.

Future research questions in this regard should be, on one hand, which form archives can take in order to generate new knowledge and involve different audiences? and on the other, how the link between cultural heritage and digital technologies is strengthened in the context of archiving and designing experience? [13] .

Digitization allows both synchronic and diachronic actions for the narration of memories. The design process in this context

have develop projects for different cultural experiences in order to foster the inclusive dimension of historical/artistic assets through archives.

Likewise, in the archaeological field, contemporary restoration techniques supported by digital technologies can define new levels of knowledge and emotional involvement of the public. Those digitization projects made possible to develop in-depth and didactic experiences that will bring the audience of students or visitors intrigued to understand the importance of the work of the restorer and perhaps even to know lesser-known stories related to a work of such great value.

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